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ABSTRACT

The relatively long-term effects of temperament on classroom achievement were studied in a cohort of elementary students while accounting for variation in cognitive ability, previous achievement, and gender. The existence of long-term effects would support the hypothesis that indirect genetic effects on learning are mediated by temperament. Initial participants were 104 children from six first-grade classrooms in one elementary school in Georgia. Scholastic aptitude was assessed in grade 1, and achievement was assessed in grades 1 and 5. Temperament measurements were obtained from the Temperament Assessment Battery for Children--Teacher Form (TABC) of R. P. Martin (1988). Achievement data were recorded for 77 of the original students when they were in fifth grade Results indicate that distractibility, activity level, and approach tendency were related to achievement in both years, with the relationship for distractibility most evident. Results support the hypothesis that temperament has important effects on learning, suggesting that high distractibility and activity level in the first grade are risk factors for poor achievement in later elementary school grades. Two tables and four flowcharts provide study data. (SLD)

Potential Indirect Genetic Effects on Learning: A Longitudinal Study of Temperament Effects on Achievement in Elementary School

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Potential Indirect Genetic Effects on Learning: A Longitudinal Study of Temperament Effects on Achievement in Elementary School

It has been known for a number of years that there are strong genetic effects on general cognitive ability defined as the speed of learning new tasks (Erlenmeyer-Kimling & Jarvik, 1963; Fuller & Thompson, 1978). In humans much of this evidence has been obtained through classical methods of behavior genetics. Recent investigations exemplified by the work of Smith, Kimberling, Pennington, and Lubs (1983) have found evidence of genetic effects on specific types of learning disabilities, and have implicated specific genes for some subjects in the reduced ability to learning certain types of material (See Pennington & Smith, 1988 for a review). Through such basic scientific work a clearer picture of direct linkages between genetic variation and learning in humans is being pieced together.

It is generally understood that a large variety of other factors effect learning in humans. One class of such factors is social and emotional behaviors which may be thought of as indirectly influencing (e.g., adverse social relationships may limit learning motivation in school) the learning process and on the performance of learned behavior. Most often these social and emotional states are thought of as having an environmental etiology; that is, they are the result of specific stressors. For example, in the case of test anxiety, the stress caused by anticipated effects of failure may impede performance.

Recently, there has been an increase in interest among developmental psychologists and others in genetic influences on social and emotional behavior. Temperament is name given to that class of personality traits that are most clearly influenced by genetic effects and are observable in young children (Buss & Plomin, 1975; 1984). Behavior genetics research as reviewed by Buss and Plomin (1975, 1984), Fuller and Thompson (1978), and Goldsmith (1983) have provided substantial support for the association between genetic

variation and variation in personality in children, particularly for those variables often referred to under the rubric of temperament.

Martin and colleagues (Martin & Holbrook, 1985; Martin, Paget, & Nagle, 1983; Paget, Nagle, & Martin, 1984; Martin, Drew, Gaddis, & Moseley 1988) and others (Bender, 1987; Keogh, 1986; Maziade et al., 1986; Pullis, 1985; Schor, 1985; Skuy, 1989) have demonstrated that some temperamental variables are related to learning and performance in educational settings, and to behavior of school personnel toward children. None of this research has studied the long term effects of temperament on classroom learning and performance in a typical public school sample. It is the purpose of this study to extend these previous research findings by studying the relatively long term effects of temperament on classroom achievement while accounting for variation in cognitive ability, previous achievement, and student gender. Should long-term effects be observed, these results would support the notion that there are indirect genetic effects on learning mediated by temperament.

Note: It is with some trepidation and considerable humility that I participate in this symposium with basic researchers of the calibre of John DeFries and Shelley Smith, and with persons with the perspective of David Grey. My trepidation is exacerbated by the fact that my research in no way demonstrates, or attempts to demonstrate, a connection between genetic effects and learning. What I have done is to take the work of the more basic scientists on temperament, and attempt to utilize one measure of these constructs to predict behavior in the classroom. It should also be noted that in measuring behavior of children 5 and 6 years of age, I make no claims to be measuring a direct expression of genetic variation, but rather am attempting to measure phenotypic expression with genetic variation being one etiological factor.

Method

Subjects

The initial participants in this study consisted of 104 children (49 males, 55 females) enrolled in six first-grade classrooms in one elementary school in northern Georgia. At the time of the first assessment, they ranged in age from 76 to 94 months (Mean = 81.59, S.D. = 4.3 months); 98 were white, 6 were black. The mean IQ on the Otis-Lennon Mental Abilities Test (Form J, Level I) was 103.3 (S.D. = 14.13) with a range from 69 to 141. Seven of the 111 students in these classes were excluded from the study because they had be retained the previous year, or had been referred for special education placement. The six teachers had an average of 9.5 years teaching experience (range from 2 to 28 years), an four held graduate degrees. The school was the only elementary school in a sparsely populated county in the foothills of the Appalachian Mountains. It was designated by the federal government as a low-income area, and received Title I funds.

Four years later, when the majority of this cohort was enrolled in the fifth grade, school records were examined and achievement data recorded. Data for 77 of the original 104 students were obtained.

Instrument

Temperament measurements were obtained from the Temperament Assessment Battery for Children--Teacher Form (TABC) (Martin, 1988). The TABC Teacher Form consists of 48 items descriptive of behaviors readily observed by teachers of elementary school children. The rater responds to each item on a 7-point scale based on the frequency with which the behavior described in the item occurs (hardly ever, infrequently, once in a while, sometimes, often, very often, or almost always).

The TABC is designed to provide measurements of six socio-emotional characteristics of children aged 3-7 years. (1) Activity--motoric vigor of the child, (2) Adaptability--speed and ease of adjustment of the child to new social situations, (3) Approach/Withdrawal--tendency to approach or withdraw from social interaction in the first encounter with a novel social situation, (4) Emotional Intensity--vigor

of emotional expression (particularly negative emotions), (5) Distractibility--tendency for the child to divert attention to non-task relevant stimuli, and (6) Persistent--attention span and tendency to continue attempting difficult learning tasks. Because recent factor analyses have raised doubts about the factorial integrity of the Adaptability scale, and have demonstrated that the items on the Distractibility and Persistence Scales tend to load on the same factor, this research reports results for the Activity, Approach/Withdrawal, Emotional Intensity, and Distractibility scales, with the last scale being an aggregate of the previous Distractibility and Persistence scales.

The Teacher Form is a modification of the Thomas, Chess, and Korn Teacher Temperament Questionnaire (Thomas & Chess, 1977). Internal consistencies in the form of Alpha Coefficients of the scales range from .86 to .74 for all scales except the original distractibility scale which was .57. When this scale was aggregated with the items from the Persistence scale, the resulting Distractibility scale had an alpha coefficient of .83. Test-retest correlations for the scales ranged from .71 to .81 for the scales used in this research (Martin & Holbrook, 1985).

Scholastic aptitude was assessed in first grade by the Otis-Lennon Mental Abilities Test (Elementary I Level, Form J). This is a group administered instrument designed to yield a measure of general "g".

In both first and fifth grade reading and mathematics achievement were assessed in two ways. First, grades in reading and mathematics were obtained from cumulative school records. For first grade, these were from the final grading period of the year, and for firth grade, there were from the mid-year grading period. Achievement was also measured through standardized test score. In first grade, the American School Achievement Test (ASAT), Revised Edition (Primary Battery I, Form Y) was used. In fifth grade, the scores were obtained from the Metropolitan Achievement Test (MAT). Both tests tapped sight word vocabulary skills as well as comprehension skills in the reading portion. The mathematics tests assessed knowledge of general issues of number and quantity in the first grade version, as well as calculation skills, with the latter emphasized in the fifth grade assessment.

Procedure

About mid-year of the first grade, teachers completed the Teacher Form of the TABC on each student in their class. Approximately five months later, the Otis-Lennon Mental Abilities Test was administered in the student's classroom. Achievement data in the form of teacher assigned grades were obtained in first grade at the end of the year, and at mid-year in the fifth grade. Standardized achievement assessment took place in the Spring of both the first and fifth grade years.

Results and Discussion

Table 1 presents correlations between first grade teacher ratings of temperament and first and fifth grade achievement scores. It can be seen from these data that Distractibility, Activity level, and Approach Tendency are meaningfully related to both first and fifth grade achievement, with the strongest relationships being between Distractibility and achievement. Emotional Intensity was significantly related only to reading grades in the first grade and then only for boys. Due to the number of relationships examined, this result may have been due to chance. While some tantalizing gender differences in the relationship between temperament and achievement can be seen in Table 1, none of these relationships reached significance.

These results for first grade achievement are consistent with those previously summarized by Martin (in press); that is, it has been shown in a number of investigations that Distractibility, Activity Level, and in some studies Approach Tendency significantly predicts achievement. These results are limited by the fact that the same teacher who did the temperament ratings also gave the grades to the children and may have been aware of standardized achievement results.

These results for fifth grade achievement extend previous results and show that at least for the Distractibility variable, strong and consistent relationships can be seen. Interestingly, variations in activity level for girls and approach tendency for boys are also predictive of fifth grade teacher grades, though not of standardized test scores.

Table 2 presents the relationships between Scholastic Ability Scores, and achievement and temperament. These data reveal that, as expected, scholastic ability is meaningfully related to achievement in both first and fifth grades, and to two of the temperament variables. Further, there are two significant gender differences. These results make it clear that there is a good deal of covariation among cognitive ability, temperament ratings, and achievement, which limits the interpretability of the zero order correlations between temperament and achievement.

This research was guided by a model that postulates that both temperament and cognitive ability play a causative role in both first grade and fifth grade achievement. Further, it seems reasonable to believe that first grade achievement would have an effect on fifth grade achievement. Given this simple model, path analyses were carried out as illustrated in figures 1 through 4. These figures present the results of path analyses in which first and fifth grade reading grades were the predicted variables.

Figure 1 illustrates that Activity Level does not make a significant contribution to first grade reading grades with cognitive ability test scores are controlled. However, Activity Level as measured in the first grade does have a significant negative effect on fifth grade reading grades. Interestingly, the path for cognitive ability and for first grade reading grades are not significant.

Figure 2 illustrates that neither Cognitive Ability nor the Approach rating had a significant path coefficient for first or fifth grade reading, with the exception of the relationship between cognitive ability and first grade reading for girls.

Emotional Intensity was demonstrated to have a significant negative path to first grade reading for boys, and Cognitive Ability Test Scores had a significant positive path for both sexes to first grade reading (see figure 3). None of the variables studied had a significant path to fifth grade reading.

Figure 4 illustrates that teacher ratings of Distractibility had a significant path to both first grade and fifth grade reading grades for boys and girls. No other path was significant.

The results of the path analyses indicate that Distractibility and Activity Level (for girls only) ratings made in first grade had significant paths to fifth grade reading achievement even when cognitive ability and first grade reading achievement was controlled. These results extend past research demonstrating short-term effects, and lend support to the hypothesis that temperament has important effects on learning. These relationships support an interpretation that high Distractibility and Activity Level as observed in the first grade classroom are risk factors for poor achievement later in elementary school.

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Table 1

Correlations Between Temperament and First and Fifth Grade Achievement

Temperament		Reading		Math	
		Grades	Standard. Test Scores***	Grades	Standard. Test Scores
Distractibility					
1st	Boys	-.68**	-.36*	-.59**	-.37*
	Girls	-.62**	-.60**	-.59**	-.55**
5th	Boys	-.47**	-.48**	-.49**	-.36*
	Girls	-.48**	-.41**	-.50**	-.23
Activity Level					
1st	Boys	-.22	-.23	-.08	-.16
	Girls	-.39*	-.49**	-.49**	-.22
5th	Boys	-.01	-.25	-.13	-.31
	Girls	-.50**	-.24	-.31*	-.28
Approach Tendency					
1st	Boys	.40*	.35*	.37*	.38*
	Girls	.47**	.39*	.42**	.50**
5th	Boys	.35*	.32	.51**	.18
	Girls	.10	.18	.17	.09
Emotional Intensity					
1st	Boys	-.35*	-.22	-.18	-.13
	Girls	.15	.06	-.06	.11
5th	Boys	-.15	-.32	-.08	-.14
	Girls	.03	.18	.17	.09

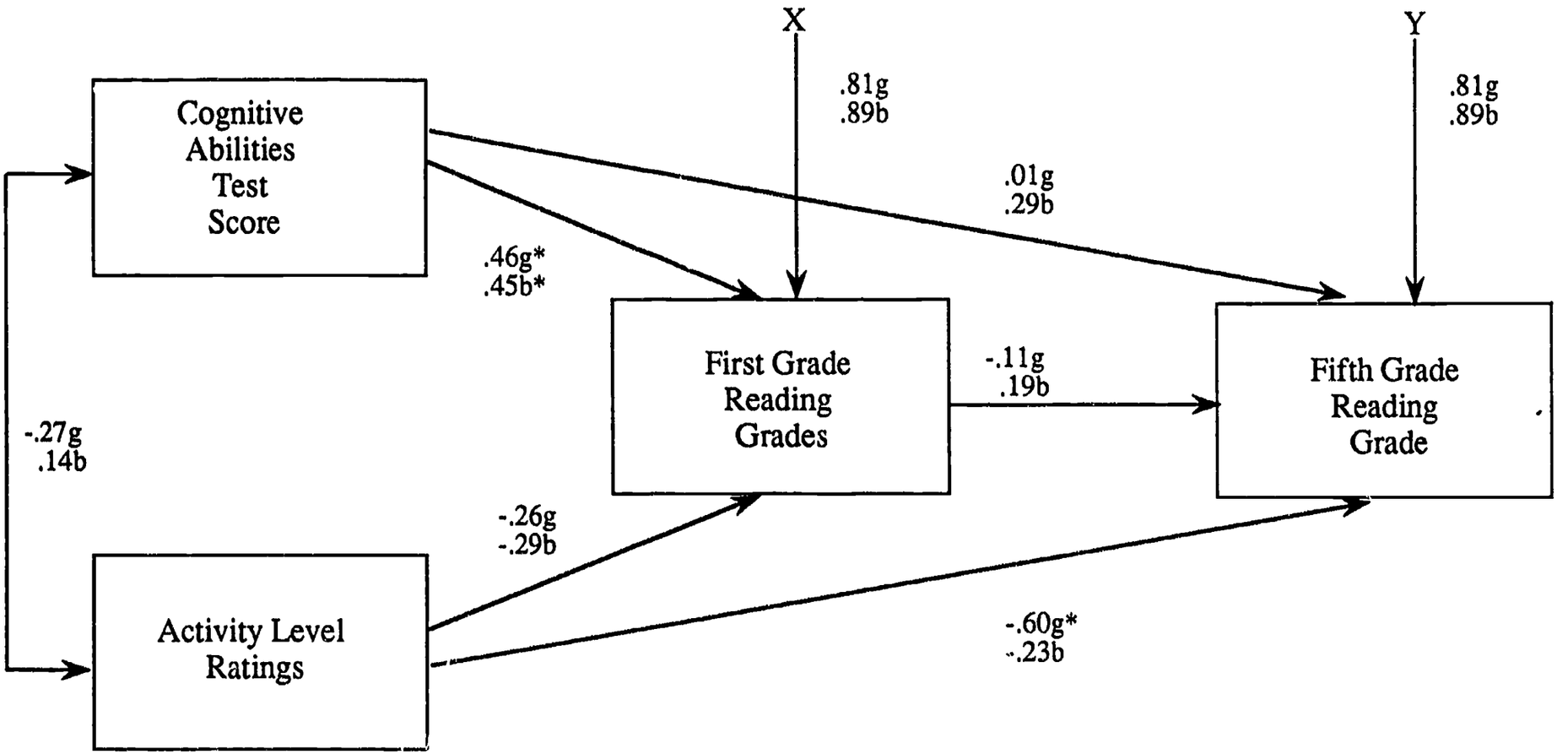
* $p < .05$
** $p < .01$
*** American School Achievement Test in first grade, Metropolitan Achievement Test in fifth grade.

Table 2

Correlations Between Scholastic Ability Scores, and Achievement Scores and Temperament Ratings

	Scholastic Ability		Gender
	Boys	Girls	Diff.
Temperament Ratings			
Distractibility	-.23	-.51**	ns
Activity Level	.14	-.27	ns
Approach Tendency	.73**	.38*	.05
Emotional Intensity	.31	.04	ns
Achievement--1st Grade			
1st Grade Reading Grades	.41**	.54**	ns
ASAT Reading Test Scores	.36*	.62**	ns
1st Grade Math Grades	.40*	.46**	ns
ASAT Math Test Scores	.48**	.55**	ns
Achievement--5th Grade			
Reading Grades	.17	.61**	.01
MAT Reading Test Scores	.40*	.56**	ns
Math Grades	.47**	.52**	ns
Mat Math Scores	.24	.46**	ns

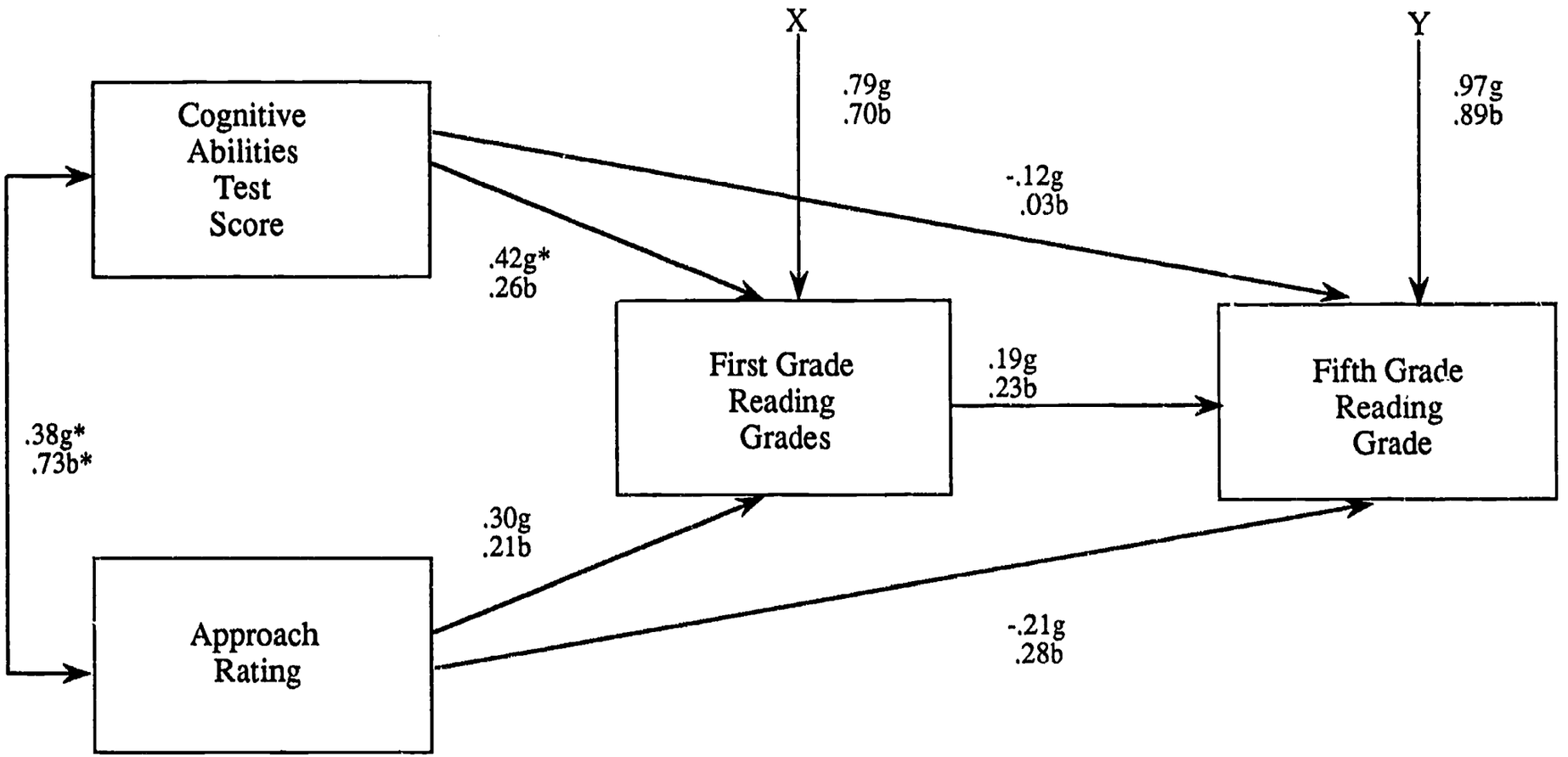
Boys n = 33
Girls n = 42
*p< .05
**p< .01



g = girls (n = 39)
b = boys (n = 33)

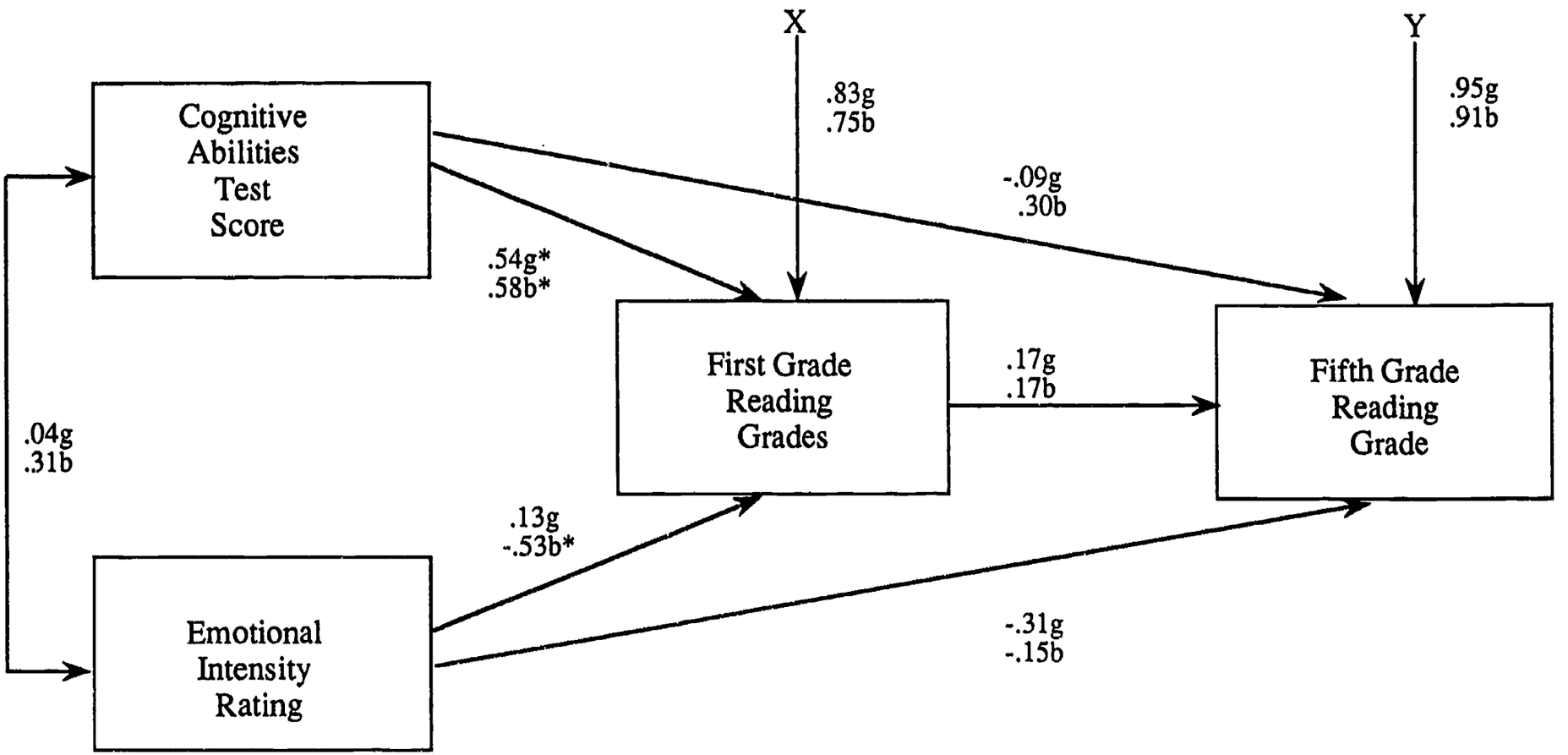
*p < .05 for path coefficients

Figure 1. Path Diagram Showing Relationship of Scholastic Ability and Activity Level to Reading Grades in First and Fifth Grade



g = girls ($n = 43$)
b = boys ($n = 33$)
*$p < .05$ for path coefficients

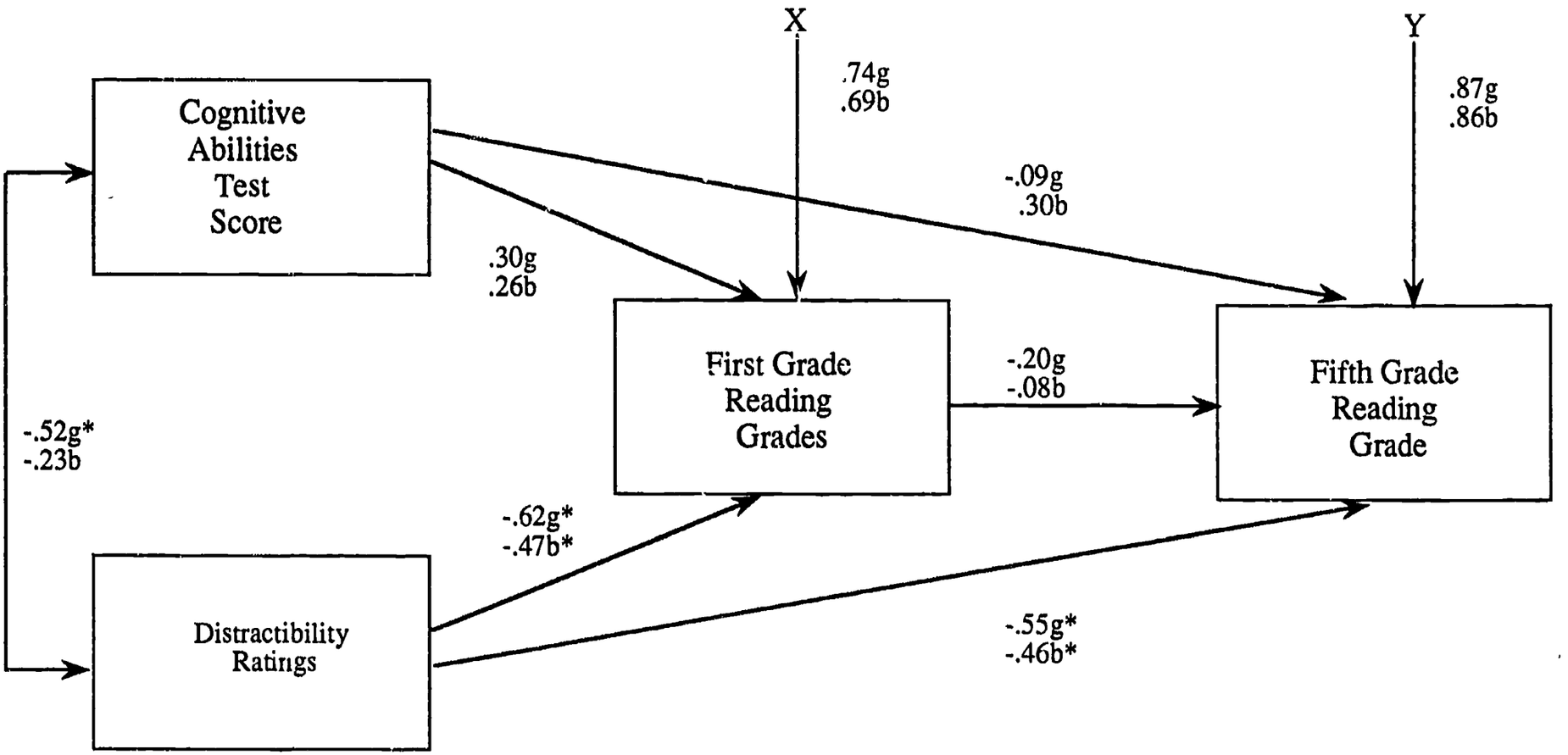
Figure 2. Path Diagram Showing Relationship of Scholastic Ability and Approach Tendendy to Reading Grades in First and Fifth Grade



g = girls ($n = 39$)
b = boys ($n = 33$)

* $p < .05$ for path coefficient

Figure 3. Path Diagram Showing Relationship of Scholastic Ability and Emotional Intensity to Reading Grades in First and Fifth Grades



g = girls ($n = 40$)
b = boys ($n = 34$)

* $p < .05$ for path coefficient

Figure 4. Path Diagram Showing Relationship of Scholastic Ability and Distractibility to Reading Grades in the First and Fifth Grades